March 12, 2013

EXHIBIT NO. CC 12

To: Sammamish City Council From: Gene Welch, Limnologist

Subject: Lake Sammamish quality and the "erosion hazard near sensitive water overlay"

Water quality in Lake Sammamish is presently very good, especially during the past decade when summer transparency has averaged over 5 m (#1). Transparency is determined by the amount of algae (chlorophyll) and the relation is non linear. That is, large changes in transparency can result from small changes in chlorophyll (chl). Since the amount of chl is determined by phosphorus, the lake's transparency and its blue appearance, is very sensitive to phosphorus.

Fortunately, annual, whole-lake (WL) phosphorus content has remained surprisingly, stable with no trend, since recovery after waste water diversion - averaging about 18 micrograms/liter (μ g/L) over he past 20 years (#2). That is well below the goal set by KC in the mid 1990s of 22 μ g/L. At that time, a thorough analysis projected phosphorus to reach 28 μ g/L at complete build out in the watershed (Perkins, 1995; Perkins et al., 1997).

The principal reason annual WL phosphorus has not increased is that feed back of phosphorus from bottom sediment into the hypolimnion (below 15 m) has dramatically decreased over the past 30 years - by 36% (1981-1992 to 1993-2011). That has translated into a 20% decrease in average hypolimnion phosphorus during summer-fall (#2). Annual WL phosphorus is strongly related to hypolimnion phosphorus over the near 50 years of record (#3). Note that summer epilimnion (top 10 m) phosphorus has also remained stable at about 12 $\mu g/L$ (#2), as well as winter phosphorus at about 23 $\mu g/L$ (not shown). This means that the decrease in hypolimnetic phosphorus has compensated for any increased phosphorus loading that may have occurred from development. Had hypolimnion phosphorus stayed at the 1981-1992 average of 28 $\mu g/L$, annual WL phosphorus would have averaged near 20 $\mu g/L$ instead of 18 currently (using equation in #3).

Another reason annual phosphorus has remained stable may be due to reduced inflow, which increased lake water residence time from 1.79 years during the mid 1960s to mid 1970s to 2.17 years from 1997 to 2011 (#4). Although only a 20% increase, lake phosphorus is very sensitive to water residence time and could have accounted for some of the decrease from the post waste water diversion phosphorus of 26 μ g/L to the current 18 μ g/L. KC's development restrictions, particularly forest retention may also acount for some of the lake's stable phosphorus.

The lake's current very good quality should not be justification for allowing increased development, because the lake is sensitive to further increases in phosphorus input:

1. Build out inflow phosphorus predicted to be 150 μ g/L, versus 89 μ g/L now.

2. 3.

Water residence time may decrease allowing lake phosphorus to increase.

Storm water enters the lake's surface water May-October (same temperatures) and a toxic blue green bloom occurred in September 1997 following storm.

4. Climate change warmed L. Washington by 3° F during 1964 to 2000 and extended the period of thermal stratification by 3 weeks. That effect would worsen the oxygen problem reducing habitat for trout and Kokanee, exacerbated by more phosphorus and algae.

Thus, I have concerns about the long-term effect of changing policy that restricts development on steep slopes, i.e., "erosion hazard near sensitive water body overlay". Retention ponds typically remove 50% of phosphorus, mostly particulate, while soluble is largely not removed and 59% of loading to the lake is biologically available which is mostly soluble. Effluents from treatment ponds would add mostly soluble phosphorus that was not retained/removed.

The purpose of the pilot project seems to be to allow limited development in order to allow increased development.

Following are some suggestions to evaluate projects:

Determine how much- soluble **and** particulate P are retained, not just total P. Determine solids **and** turbidity retention; small particles settle slowly and would show up as turbidity.

7 sample collections/yr not enough, continuous daily sampling is necessary. Match peak flows, in addition to total annual volumes. Big storms do the damage and transport the most sediment and phosphorus.

Hydroseeding contains lots of easily leached P, not like turf fertilizer, in which phosphorus is banned.

Perkins, W. W. 1995. Lake Sammamish total phosphorus model. King County Surface Water Management, July.

Perkins, W. W., E. B. Welch, J. Frodge and T. Hubbard. 1997. Zero degree of freedom total phosphorus model: Application to Lake Sammamish, Washington. Lake and Reserv. Manage. 13:131-141.







